AD_____

REPORT NO T12-90

RELATIONSHIPS BETWEEN BODY FAT AND APPEARANCE RATINGS OF U.S. SOLDIERS

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

FEBRUARY 1990

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DISPOSITION INSTRUCTIONS

Destroy this report when no longer needed.

Do not return to the originator.

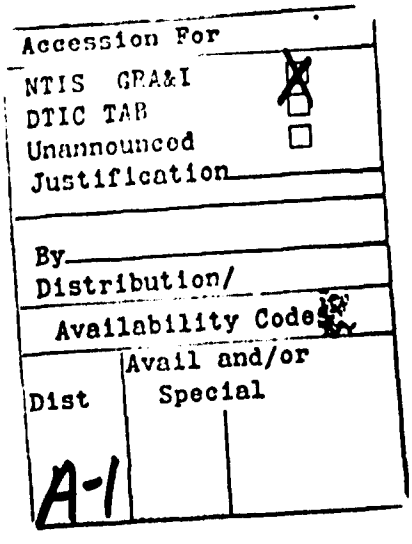
Disclaimer

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy, or decision, unless so designated by other official documentation.

Human subjects participated in this study after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

Citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.

Approved for public release; distribution is unlimited.



TECHNICAL REPORT

NO. T12-90

RELATIONSHIPS BETWEEN BODY FAT AND APPEARANCE RATINGS OF U.S. SOLDIERS[1]

BY
James A. Hodgdon, Ph.D.[2]
CPT Patricia I. Fitzgerald, AMSC[3]
James A. Vogel, Ph.D.

EXERCISE PHYSIOLOGY DIVISION
US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE,
NATICK, MA 01760-5007

and

NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122, SAN DIEGO, CA 92138-9174

JANUARY 1990

[1] This report is also appearing as Report No. 90-1 from the Naval Health Research Center, San Diego, CA.,

[2]. Dr. Hodgdon is Head, Operational Performance Programs, Naval Health Rsch Center, San Diego, CA.

[3]. CPT Fitzgerald is currently at the Academy of Health Sciences, Fort Sam Houston, TX.

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION: U. S. Army Research Institute of Environmental Medicine; 6b OFFICE SYMBOL (If applicable): SGRD-UE-PH	7a NAME OF MONITORING ORGANIZATION: Same as 6a.
6c ADDRESS (City, State, and ZIP Code): Kansas St. Natick, MA 01760-5007	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION; 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 3E162787A879; PROJECT NO. 879/BF; TASK NO. 879/BF; WORK UNIT ACCESSION NO. 133

11 TITLE (Include Security Classification)

Relationships between body fat and appearance ratings of U.S. soldiers

12 PERSONAL AUTHOR(S) James A. Hodgdon, Patricia Fitzgerald, James A. Vogel

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Manuscript	FROM Jun 84 TO Nov 84	January 1990	38

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Body composition, body fat, appearance, visual assessment;

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Military Service requirements to maintain physical appearance drive, in part, the Service standards for maximum weight for height and/or body composition. This report considers two issues: 1) how strongly are ratings of "military appearance" and fatness associated, and 2) can reliable, valid assessments be made visually in a military population which includes both genders and contains members of varying race and age. A panel of 11 U.S. Army headquarters staff personnel made visual ratings of 1075 male and 251 female U.S. Army personnel from photographs of the subjects both in uniform and in swimsuit. Subjects were rated for "appearance" in both uniform and swimsuit using a 5-point scale, and for "fatness" in swimsuit using a 7-point scale developed by Blanchard and co-workers. Inter-rater reliabilities of the scales were 0.86, 0.90, and 0.92 for appearance in uniform, appearance in swimsuit, and fatness in swimsuit, respectively. Correlations between ratings and percent fat from hydrodensitometry were 0.53, 0.69, and 0.78 for appearance in uniform, appearance in swimsuit, and fatness, respectively, for males in this sample. Similar correlations were 0.46,

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

0.60, and 0.72 for females. Analysis of variance using percent body fat as a covariate revealed significant gender and race main effects and a gender by age interaction in ratings of appearance in uniform; gender and age by gender effects in ratings of appearance in swimsuit; and a gender effect in ratings of fatness. For a given percent body fat value, a woman received a higher rating of military appearance, and a black soldier received a higher rating of military appearance. The gender by age interaction appears to reflect an increased sensitivity in rating older females than younger females or males of either age group. Validities for prediction of percent body fat from ratings of fatness approach those for prediction from anthropometric variables. Ratings of appearance appear to involve more than a consideration of the fatness of the individual. Thus a single rating scale for appearance and fatness is not feasible. Visual ratings of fatness appear to be valid, reliable indicators of percent body fat.

CONTENTS

	Page
List of Figures	vi
List of Tables	vii
Foreword	viii
Acknowledgments	ix
Executive Summary	1
Introduction	2
Methods	3
Results	9
Discussion	20
Conclusions	22
References	22
Appendix	25
Distribution List	26

List of Figures

		Page
1.	Layout of photographic equipment	6
2.	Example photographs taken for the uniform and swimsuit appearance and fatness assessments in male soldiers.	7
3.	Example photographs taken for the uniform and swimsuit appearance and fitness assessments in female soldiers.	8
4.	Pictorial overview of male soldiers comparing individual fatness rating, swimsuit and uniform appearance rating at six levels of percent body fat (rounded to the nearest 5%).	18
5.	Pictorial overview of female soldiers comparing individual fatness rating, swimsuit and uniform appearance rating at five levels of percent body fat (rounded to the nearest 5%).	19

List of Tables

		Page
1.	Participant characteristics	11
2.	Inter-rater reliability of the measurers	11
3.	Correlation matrix-body fat and ratings	11
4.	Regressions to predict percent fat	12
5.	Percent body fat by gender, age and race	13
6.	Breakdown of appearance in uniform by gender, age and race	13
7.	Analysis of variance effects of race, gender, and age on uniform appearance	14
8.	Breakdown of appearance in swimsuit by gender, age and race	15
9.	Analysis of variance effects of race, gender and age on swimsuit appearance	15
10.	Breakdown of fatness rating by gender, age and race	16
11.	Analysis of variance effects of race, gender and age on fatness rating	16
12.	Validities of generalized anthropometric equations	21

Foreword

This Institute was requested in 1983 by the Office of The Surgeon General to carry out research with the objectives of developing objectively-based body weight/body fat retention standards for the Army as well as developing improved methods of field assessment of body fat. Appearance is one of several criteria that can be considered in the development of body fat standards. This report presents data addressing this issue.

Acknowledgments

Many staff members from the Institute supported and made this study possible. Those involved in the photographic assessment and hydrostatic weighing to which we wish to express our appreciation are: Rosemary Wildgoose, James O'Connell, Margaret Kinney, Richard Wilson, Marilyn Sharp and Pamela Reich. Emily Hamilton is gratefully acknowledged for her administrative support to the study and this manuscript.

EXECUTIVE SUMMARY

All military Services stress the maintenance of appropriate physical appearance. These appearance requirements, in part, drive the Services' standards for maximum weight-height and/or body composition. There is, however, no research to demonstrate associations between military appearance and body composition.

There is previous work to suggest that visual estimation of fatness may be a reliable, valid technique for the determination of body fat content. However, it is unclear how well these previous results will generalize across genders, races, or age groups.

This report considers two issues: 1) how strongly are ratings of "military appearance" and fatness associated; and 2) can reliable, valid assessments of fatness be made visually in a military population which includes both genders and contains members of varying race and age.

The general approach taken was to determine the relative fatness of individuals in a sample of 1326 U.S. Army active duty personnel (1034 enlisted, 216 officer, and 76 warrant officers; 1075 male and 251 female) by hydrodensitometry. Photographs of the same subjects were taken both in uniform and in swimsuits. These photographs were then rated by group of 11 experienced troop leaders (5 female, 6 male; 6 officer, 5 enlisted) as to their "military appearance" in both uniform and in swimsuit, using a 5-point scale, and their "fatness" in swimsuit, using the 7-point scale developed by Blanchard and coworkers (1979).

Inter-rater reliabilities of the scales were 0.86, 0.90, and 0.92 for appearance in uniform, appearance in swimsuit, and fatness rating in swimsuit, respectively. Reliability of the ratings did not differ significantly as a function of the gender rated.

Correlations between ratings and percent fat from hydrodensitometry in this sample are: 0.53, 0.69, and 0.78 for appearance in uniform, appearance in swimsuit, and fatness for males, respectively. Comparable correlations are 0.46, 0.60 and 0.72 for females. Appearance in uniform is only modestly correlated to fatness determined from underwater weighing. Comparing the ratings in swimsuit, rating "fatness" using a 7-point scale provides a stronger relationship between the rating and percent fat than the 5-point rating of "appearance".

Analysis of variance was used to determine gender, age and race effects on ratings. Percent body fat was used as a covariate because there were significant gender, age, and race variations in percent fat. The analysis of variance revealed significant gender and race differences and a significant age by gender interaction in uniform appearance ratings. The gender effect was that for a given percent body fat value, a woman received a higher rating of military appearance. For a given percent fat, a black soldier received a higher rating of military appearance. The interaction appears to reflect an increased sensitivity (a smaller increment in fat increase leads to a greater decrease in appearance rating) in rating older females than younger females or males of either age group. Similar gender and gender by age effects

were found for the rating of appearance in swimsuit. A gender effect only was found for the rating of fatness.

Comparison of the validities for prediction of body fat from the fatness ratings are only slightly less than the mean correlations between predicted and measured percent fat (0.83 for males; 0.75 for females) from equations using anthropometric variables (skinfolds and circumferences).

It was concluded that: 1) Ratings of appearance involve more than a consideration of the fatness of the individual. Therefore, it is not feasible to establish a single visual rating procedure which can be used to rate both military appearance and fatness; and 2) Visual ratings of fatness appear to be valid, reliable indicators of percent body fat. The validity of the procedure is only slightly less than that for prediction using anthropometric equations.

INTRODUCTION

All military Services stress the maintenance of appropriate physical appearance. These appearance requirements in conjunction with health maintenance and job performance criteria, drive the Services' standards for maximum weight-height and/or body composition.

Although physical appearance is a strong determinant of the Services' weight/fat standards, there has been virtually no research done to demonstrate the nature of the relationship between "military" appearance, assessed in a standardized fashion, and actual measures of body composition or height and weight. This report describes such a study.

Previous work has suggested that visual estimation of fatness may be a reliable, valid technique for the determination of body fat content. In 1951, Dupertuis and coworkers found a correlation of -0.85 between ratings of endomorphy using Sheldon's (1940) visual somatotyping scheme and body specific gravity. This work was extended by Brozek and Keys (1952) to show that the association held for subjects who were measured prior to and following a period of semi-starvation (mean $r = .67$).

In 1976, Ward, Sutherland and Blanchard published a report dealing wi th the evaluation of body composition of human subjects by means of visual appraisal. These workers developed a system of evaluating three categories: Frame, Muscle Development, and Fatness by comparing individuals or photographs of individuals with a set of reference photographs. Frame was scored on a 3-point scale where 1 indicated "rugged"; 2, "medium"; and 3, "slight". Muscle development was evaluated using a 7-point scale with categories ranging from 1, "Extraordinary" to 7, "Under-developed". Fatness was also evaluated using a 7-point scale with categories ranging from 1, "No obvious fat" to 7, "Obese". The reference photographs were of young men representing each of the scale values (frame=1,2,..; muscle=1,2,...; etc.). These authors report repeatabilities of 0.55 for muscle development to 0.85 for fat from experienced judges, suggesting that fatness, at least can be reliably

determined from visual information. Correlations of 0.56, 0.42, and 0.69 were reported between visual ratings of fatness and % body fat from potassium-40 counts, water volume displacement, and deuterium dilution, respectively. In 1979, this group (Blanchard et al. 1979) expanded portions of the 1976 work. They focused only on the rating of fatness, and provided verbal descriptions to the raters for each of the seven levels of fatness rating. In this work, correlation coefficients of 0.56 and 0.69 were calculated between visual ratings of fatness and fat mass from potassium-40 counts, and deuterium dilution, respectively, replicating their earlier findings.

Sterner (1984) also investigated visual estimation of fatness. In his Master's work, two raters viewed photographs of male subjects, compared them with a set of five reference photographs of males whose body fat content had previously been determined. The raters were asked to estimate the subjects' percent body fat to the nearest unit. Correlations between percent fat determined from hydrodensitometry and that from visual estimation were 0.80 and 0.79 for each of the two raters, respectively. Test-retest correlations were 0.93 and 0.95 for each of the raters, respectively.

This prior work was found to be quite promising in terms of the efficacy of visual estimates of fatness. However, the extent to which the findings generalize across genders (only male subjects were used in the studies reported above), across races, and across age groups remains to be determined.

With the above background, this paper will consider two issues: 1) how strongly are ratings of "military appearance" and fatness associated, and 2) can reliable and valid assessments of fatness be made visually in a military population which includes both genders and contains members of various ages and races.

METHODS

Procedures.

The general approach taken was to determine the relative fatness of individuals in a sample of U.S. Army personnel by hydrodensitometry. Photographs of the same subjects were taken both in uniform and in swimsuits. These photographs were then rated by a group of experienced troop leaders as to their "military appearance" and their "fatness". Associations between these ratings and percent body fat were then assessed for these individuals.

Subjects

The data required for this study were collected as part of a larger effort to re-evaluate body fatness standards and methodology for the Army's weight control program (Fitzgerald et al, 1986). Subjects for this study were 1326 U.S. Army active duty personnel. Of the subjects, 1034 were enlisted, 216 were officers, and 76 were warrant officers. The gender distribution was 1075 male and 251 female.

The sample was not stratified to represent age, race, or officer/enlisted breakdowns within the Army.

Data were collected during three, 3-week iterations at two locations: Fort Hood, Texas and Carlisle Barracks, Pennsylvania. Fort Hood offered the opportunity to select from a wide variety of military personnel since it is the largest Army post in the United States. Carlisle Barracks, the home of the Army War College, was included to provide the upper age categories which were not readily available at Fort Hood.

Each testing day data were collected on 50-55 soldiers. Soldiers reported for testing either from 0730-1230 or 1300-1800 hours without any prior instructions regarding food or fluid intake. They reported in their Class A uniform, with blouse. As required by AR 70-25, subjects were briefed as to the nature of the study and requirements of their participation and that their participation was voluntary. Approximately 3% of those soldiers briefed declined to volunteer. Those agreeing to participate signed a statement of informed consent and were photographed in their Class A uniform, in bathing suits, and had their body composition determined by underwater weighing.

Body Composition.

Body composition was determined from hydrodensitometry. Soldiers were initially weighed in air on an electronic platform balance wearing a swimsuit. They then had their residual lung volume determined, and were then weighed under water. Residual lung volume was determined by a simplified oxygen rebreathing technique (Wilmore, et al; 1980) just prior to the actual underwater weighing process. Determinations were made with the subject sitting outside the underwater weighing tank in a position similar to that utilized during the underwater weighing. Two determinations were made. If there was greater than 150 ml. difference between them, a third measure was taken, and the two closest values were averaged.

Underwater weighing was conducted in a 4X4X5 foot aluminum tank. Subjects were weighed in nylon swim suits on an aluminum chair which was coupled to a load cell (Ametek) sensitive to 10 g. and suspended from a stainless steel trapeze. Output from the load cell was fed through an analog-to-digital converter (Hewlett-Packard) to a desk top computer (Hewlett-Packard 85). Load-cell force values were stored for subsequent determinations of a stable underwater weight and body composition parameters.

The method for determining body density was similar to the one described by Goldman and Buskirk (1961). The soldier was weighed with an 8-kg. weight belt, and a noseclip, and exhaled through a snorkel while under water. A series of 7-10 trials were taken. Body density was calculated using the formula of Buskirk (1961). Body density (g/cc) was converted to percent body fat using the formula of Siri (1961). A more detailed description of the underwater weighing system and procedure has been presented in a separate technical report (Fitzgerald et al, 1987).
Photographic Assessment.

Black and white, 2.25 x 2.25 inch photographs were taken of each subject, using a Mamiya 625 J camera with an 80mm, f2.8 lens. The camera and lens were supported by a tripod (Slik U212) which had an internal leveling apparatus. The arrangement of the photographic equipment is depicted in Figure 1. The camera was positioned 391 cm perpendicularly in front of the subject, at a height of 114 cm from the floor to the top of the camera body. Lighting was supplied using 4 quartz lights (Smith-victor K62) which were positioned in pairs at 165 cm and 330 cm from the subject. Black and white Kodak 220 roll film (Tri-X) was used with a 1/60 second shutter speed and f8 aperture.

Both the uniform and the bathing suit photographs were taken with the soldier wearing a mask to conceal his or her identity. Front, side and back views were photographed. Uniform photographs were taken with the soldier in the Class A uniform in the position of attention in front a measured grid. Bathing suit pictures were taken with the soldier positioned using a standard anthropometric pose (Dupertuis, 1950). Males were clad in a black, nylon swim suit and females wore a one piece, dark colored nylon swim suit. Photographs were taken following the suggestions of Tanner (1949) and Carter (1983). Figures 2 and 3 are examples of the photographs that resulted from the above process.

Rating of Fatness and Appearance.

A panel of Army personnel was formed to rate the appearance and fatness of the soldiers. The panel contained 11 members (5 female, 6 male); 6 officers, 5 enlisted, and included both black and white raters. The group consisted of representatives from the US Army Military Personnel Center, Headquarters Training and Doctrine Command, Office of the Chief of the Army Reserve, National Guard Bureau, Soldier Support Center, and Headquarters Forces Command. Each rater had extensive troop leadership or command experience.

Fatness was rated for the swimsuit photographs only using the seven-point scale described by Blanchard and coworkers (1979) with descriptive anchors provided for each of the seven rating values. A value of "1" was given the rating "very thin", and a value of "7", the rating "obese". This scale with its label descriptors is provided as Appendix (A). Raters were provided with a copy of the rating scale, including descriptors, before the rating sessions, and told to use this scale in rating the photographs.

Appearance was rated both in Class A uniform and in swimsuit. Raters were instructed to use a five-point scale for the rating of appearance, where a value of 1 was labeled "poor", 2 was fair, 3 was good, 4 was very good and a value of 5, labeled "excellent". For the ratings of appearance in uniform and in swimsuit, the raters were instructed to rate the "military appearance" of the soldier according to their own personal standards. For the ratings of appearance in uniform, the raters were given the additional instruction to evaluate how the individual looked in uniform,

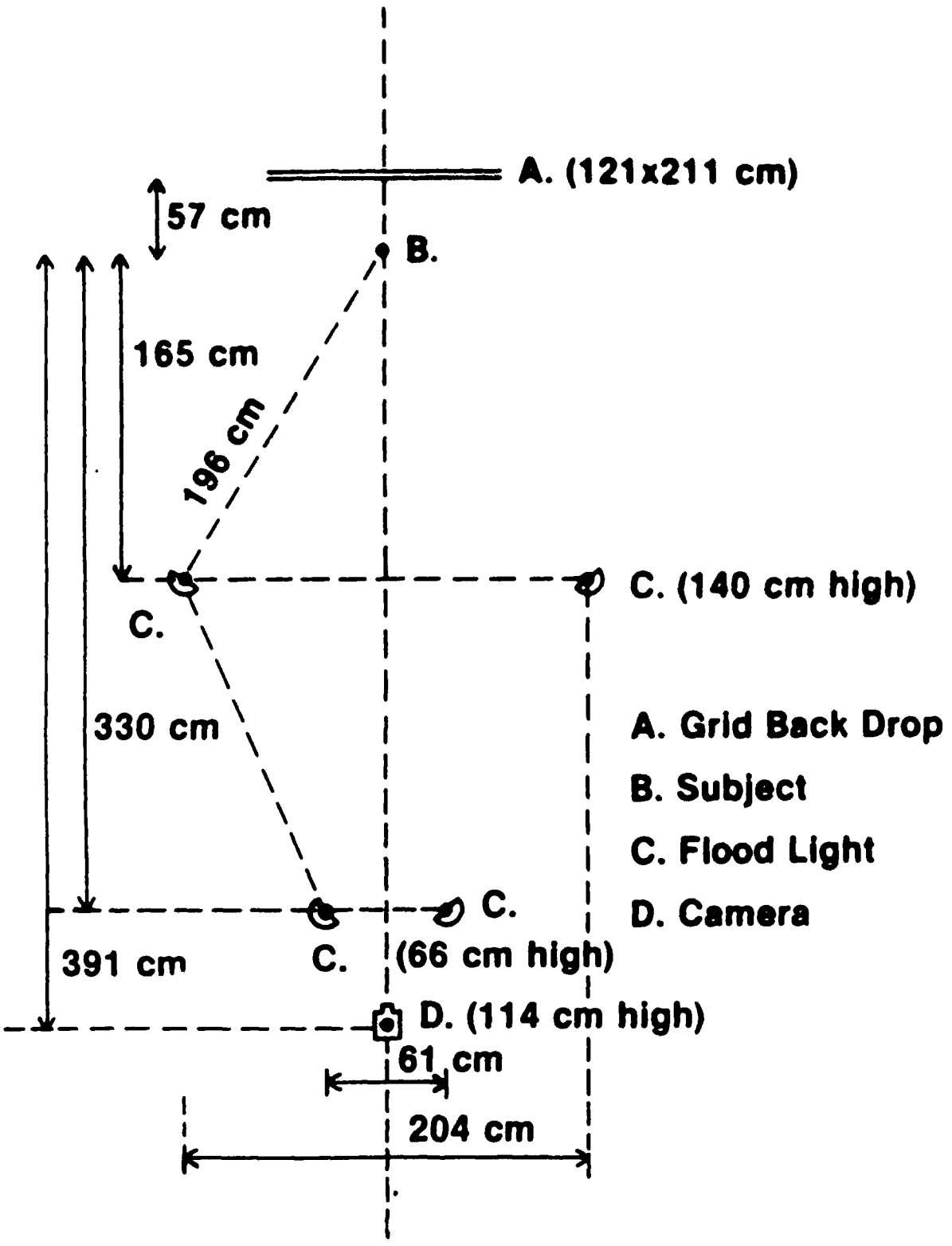


Figure 1. Layout of photographic equipment.

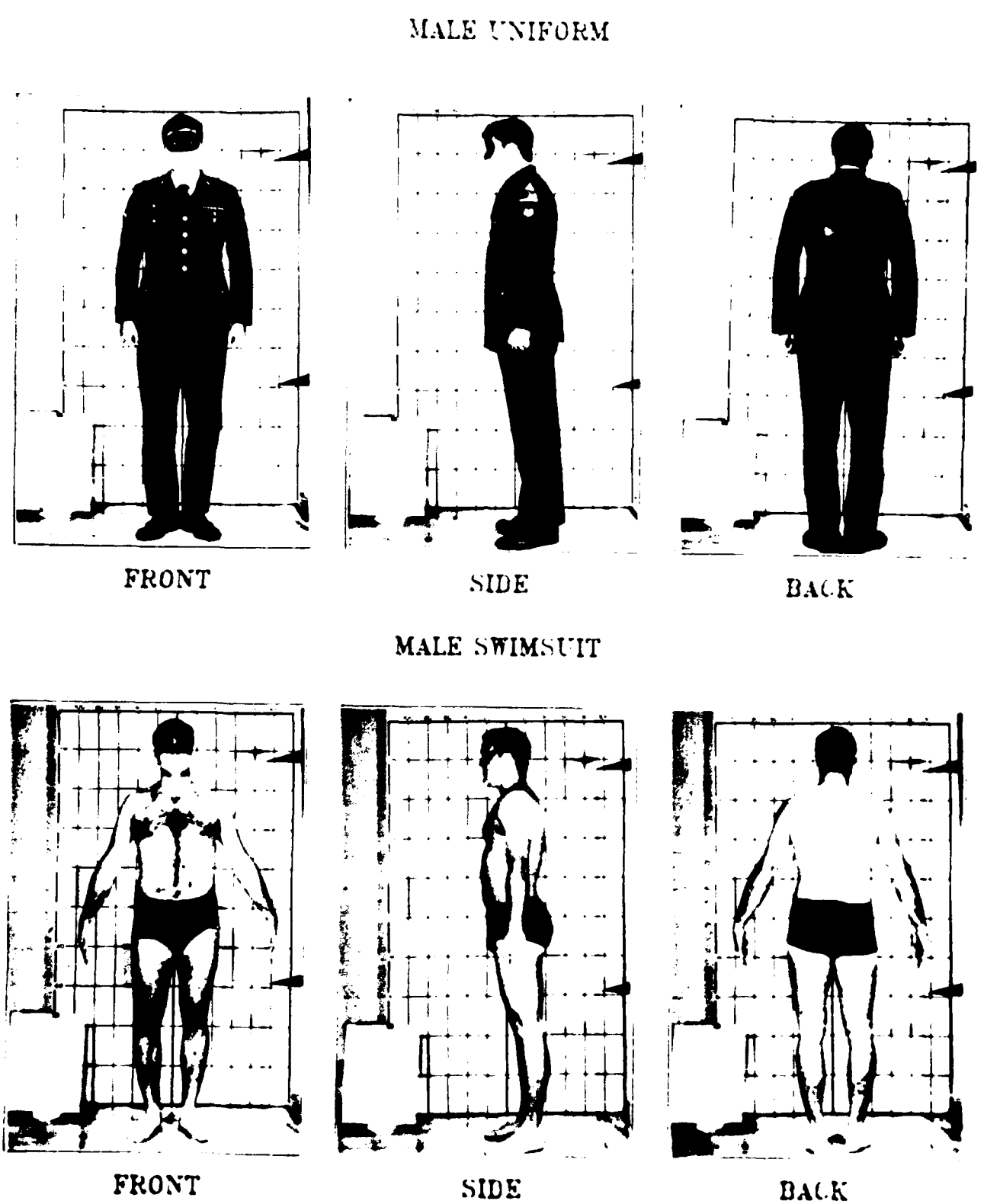


Figure 2. Example photographs taken for the uniform and swimsuit appearance and fatness assessments in male soldiers.

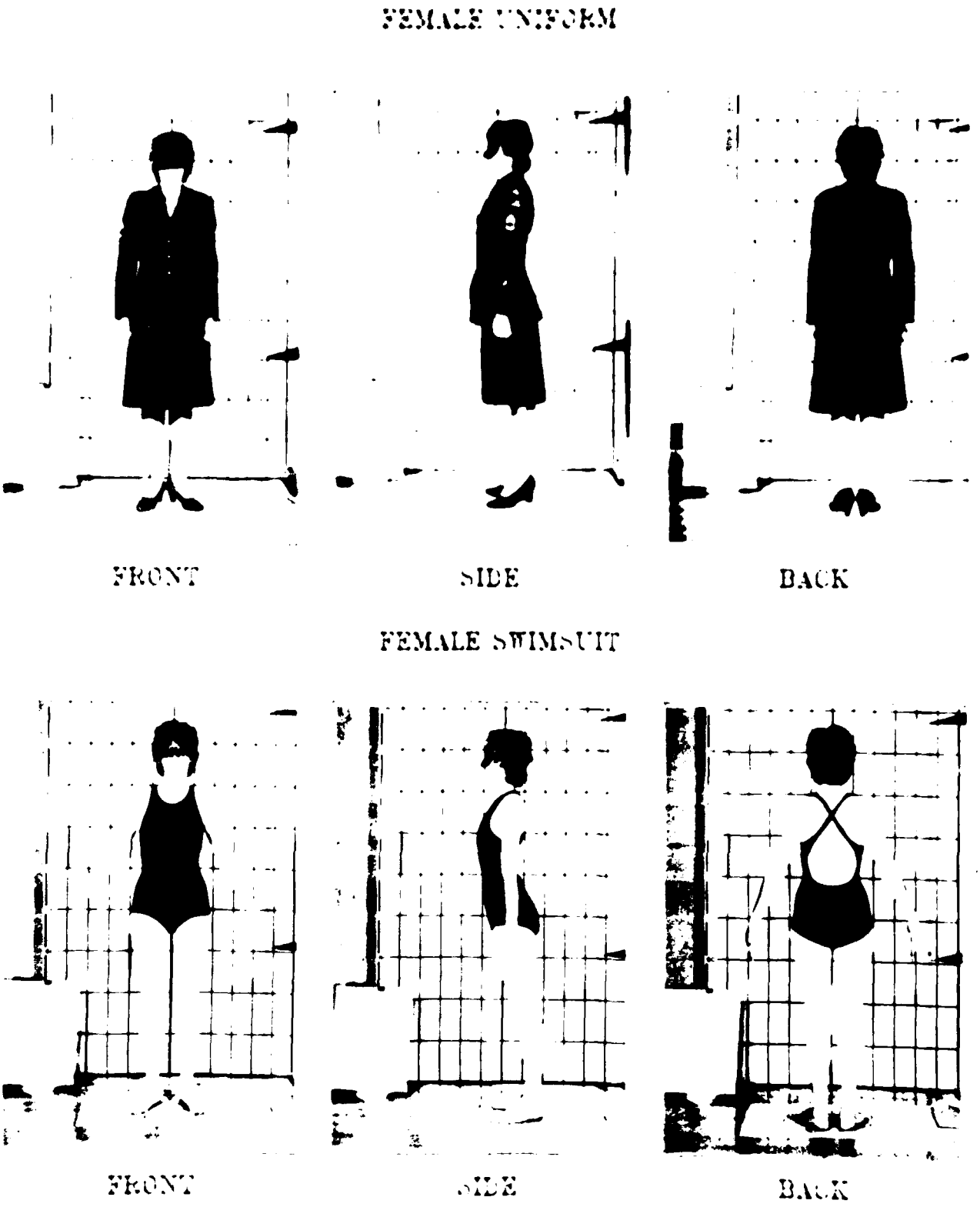


Figure 3. Example photographs taken for the uniform and swimsuit appearance and fatness assessments in female soldiers.

To present the photographs, three projectors were set up and the three photographic views were shown simultaneously. The projectors were positioned to allow for almost "life-size" projections which were viewed for approximately 20 seconds. Slides of soldiers in the Class A uniform were rated during the first half of the week, followed by rating of the soldiers in swimsuits. At the presentation of the swimsuit slides, ratings of both appearance and fatness were obtained.

The entire rating process was completed during 5 consecutive working days. Raters reported to an assigned room and spent 8 hours rating photographs with a 1-hour break for lunch and other, arbitrarily spaced, short breaks during the day.

Analysis.

Inter-rater reliability of the appearance and fatness ratings was assessed using the RELIABILITY procedure in SPSS-X (SPSS, Inc.; 1988). Nine of the eleven raters rated a common subset of 1204 subjects in uniform (949 male, 255 female), and 993 soldiers in swimsuits (768 male, 225 female). Of the 993 soldiers rated in swimsuits, 957 (743 male, 214 female) had their fatness assessed. Based on values from these nine raters, inter-rater reliabilities were assessed for each gender for appearance and fatness ratings. Each rater's rating was treated as one of nine individual scale items, and the inter-rater reliability expressed as Cronbach's "alpha" (Carmines and Zeller, 1979).

Validity of the fatness and appearance ratings was assessed using the SPSSX REGRESSION (SPSS, Inc.; 1988) procedure. Correlations between ratings and percent body fat determined from the hydrodensitometry were calculated and regression formulae were determined to predict percent body fat from the appearance and fatness ratings.

Effects of gender, age and race on the ratings received were assessed by analysis of variance using the SPSSX MANOVA procedure (SPSS, Inc.; 1988). For this analysis, subjects were classified according to gender (male; female), age (less than 26 years; 26 years or greater), and race (white; black - other racial groups were omitted from this analysis because they were not present in sufficient numbers). Significant differences in mean percent body fat were detected between gender and racial groups in this sample. Therefore, in the analysis of gender, age, and race effects, percent fat was used as a covariate.

RESULTS

Study participants.

Table 1. provides a listing of the characteristics of the male and female participants in this study. Comparison of mean values for the men and women (t-test; SPSS, Inc.; 1988) showed that, on the average, the men had significantly greater ($p<0.05$) height, weight, age, body density, and fat free mass than the women, and

significantly lesser body fat content and fat mass. The men were also found to have slightly, but significantly ($t=2.16$, $p=0.03$) greater ratings in uniform. Men and women did not differ significantly in the average values of their appearance or fatness ratings in swimsuits.

Reliability of the measures.

Table 2 provides the inter-rater reliabilities for the appearance ratings in uniform and swimsuit, and for the fatness rating in swimsuit for each gender rated. The reliabilities were found not to differ significantly across genders ($p=0.58$, 0.17, and 0.37 for uniform appearance, swimsuit appearance, and fatness rating, respectively - see Comparison of correlation coefficients, p. 179, Diem, 1962). The ratings are more reliable for evaluations in swimsuits than those in uniform; and the fatness ratings have greater inter-rater reliability than the appearance judgments.

Body composition relationships.

Table 3 provides the matrix of correlations between predictor and criterion variables for each gender. For each gender, the correlations between the ratings and percent fat determined from hydrodensitometry are greater for swimsuit appearance than for appearance in uniform; and are greater for fatness ratings in swimsuit than for swimsuit appearance ratings. The correlations between fatness ratings and percent body fat approach the correlations obtained between anthropometric variables and percent body fat on a larger sample of Army subjects (Vogel et al, 1988).

Table 1. Participant Characteristics. Mean (SD)

	Males (n=1075)	Females (=251)
Height (cm)	175.1 (6.9)	162.5 (6.2)
Weight (kg)	77.1 (11.2)	60.3 (8.1)
Age (yrs)	30.1 (8.9)	24.0 (5.7)
Body Density (kg/l)	1.052 (0.015)	1.036 (0.012)
Body Fat Content (% body wt)	20.6 (6.9)	28.0 (5.7)
Fat-free Mass (kg)	60.9 (7.3)	43.1 (4.8)
Fat Mass (kg)	16.3 (7.1)	17.1 (5.2)
Appearance Rating in Uniform	3.31 (0.62)[1]	3.21 (0.67)[4]
Appearance Rating in Swimsuit	3.12 (0.68)[2]	3.15 (0.77)[5]
Fatness Rating in Swimsuit	3.58 (0.92)[3]	3.58 (0.92)[6]

[1]N = 988 [2]N = 862 [3]N = 860 [4]N = 233 [5]N = 211 [6]N = 209

Table 2 - Inter-Rater Reliability of the Measures.

	Males	Females
Appearance in Uniform:	0.86	0.87
Appearance in Swimsuit:	0.89	0.91
Fatness:	0.92	0.93

Table 3 - Correlation Matrix - Body Fat and Ratings

Males:

	% Fat from Densitometry	Uniform Appearance	Swimsuit Appearance
Uniform appear.	-.530		
Swimsuit appear.	-.686	.626	
Fatness rating	.785	-.633	-.802

Females:

Uniform appear.	-.464		
Swimsuit appear.	-.598	.746	
Fatness rating	.722	-.630	-.811

Table 4 provides regressions for each gender for the prediction of percent fat from hydrodensitometry from appearance ratings in uniform and swimsuit, and from the fatness rating. Comparison of the slopes and intercepts of the regressions (t-test, see Diem, 1962) between genders reveals that the slopes differ significantly for each of the three pairs of equations ($p<0.001$). The intercepts do not differ significantly between genders for the appearance equations ($t=0.28$, $df=1217$; and $t=0.47$, $df=1069$ for the uniform, and swimsuit equations, respectively), but do for the fatness estimation ($t=16.96$, $df=1065$).

Effects of gender, age, and race.

The breakdown of mean percent body fat values by gender, age and race are provided in Table 5. Analysis of variance reveals significant gender ($F(1,1217)=407.12$, $p<0.001$), age ($F(1,1217)=63.94$, $p<0.001$), and race ($F(1,1217)=37.63$, $p<0.001$) differences in percent body fat. Because of these differences, analyses of variance to explore gender, age, and racial differences in ratings were assessed using percent fat as a covariate.

Table 4 - Regressions to Predict Percent Fat

Predictor	Regression Coefficient	Constant	Multiple R	R2	Std. Error of Estimate
Males:					
1. Appearance in Uniform	-5.96	40.34	0.53	0.28	5.87
2. Appearance in Swimsuit	-7.04	42.55	0.69	0.47	5.04
3. Fatness	5.90	-0.51	0.78	0.62	4.30
Females:					
1. Appearance in Uniform	-3.97	40.67	0.46	0.22	5.11
2. Appearance in Swimsuit	-4.49	42.10	0.60	0.36	4.63
3. Fatness	4.54	11.69	0.72	0.52	3.99

Table 5. Breakdown of Percent Body Fat by Gender, Age and Race*

Males:

	White	Black
Less than 26 years:	18.1 (5.8) (n = 206)	13.4 (5.4) (n = 83)
26 or More Years:	24.1 (5.6) (n = 366)	18.2 (8.0) (n = 87)

Females:

	White	Black
Less than 26 years:	27.8 (5.9) (n = 86)	26.6 (4.7) (n = 50)
26 or more years	29.8 (+5.6) (n = 33)	28.3 (+6.6) (n = 17)

* Values shown are means with std. dev. in parentheses.

Table 6. Breakdown of Appearance in Uniform by Gender, Age and Race*

Males:

	White	Black
Less than 26 years:	3.30 (0.53) (n = 206)	3.57 (0.52) (n = 83)
26 or more years:	3.23 (0.61) (n = 366)	3.38 (0.75) (n = 87)

Females:

	White	Black
Less than 26 years:	3.33 (0.69) (n = 86)	3.31 (0.48) (n = 50)
26 or more years:	3.15 (0.73) (n = 33)	3.02 (0.72) (n = 17)

* Values shown are means with std. dev. in parentheses.

Table 7. Analysis of Variance Effects of Race, Gender, and Age on Uniform Appearance.

Source of Variation	SS	DF	MS	F	Sig of F
Within Cells	239.49	919	.26		
Regression (% Body Fat)	102.27	1	102.27	392.43	.000
Race	1.52	1	1.52	5.83	.016
Gender	11.65	1	11.65	44.71	.000
Age	.05	1.	.05	.18	.672
Race by Gender	.08	1	.08	.31	.577
Race by Age	.61	1	.61	2.33	.127
Gender by Age	2.48	1	2.48	9.52	.002
Race by Gender by age	.04	1	.04	.14	.713

Appearance in Uniform.

Table 6 shows the breakdown of ratings of military appearance in uniform by age, gender, and race. Table 7 contains the results of the analysis of variance for the breakdown. As can be seen for Table 7, there were significant ($p<0.05$) gender and race main effects, and a significant age by gender interaction. The nature of the main effect for gender is that for a given percent body fat value, a woman will receive a higher rating of military appearance. For a given percent body fat value, a black soldier will receive a higher rating of military appearance. The interaction appears to reflect an increased sensitivity (a smaller increment in fat increase leads to a greater decrease in appearance rating) in rating older females than younger females or males of either age group.

Appearance in Swimsuit.

Tables 8, and 9 show the breakdown, and analysis of variance, respectively, of the ratings of appearance in swimsuit. For this rating, a significant ($p<0.05$) gender effect and a significant age by gender interaction were found. The gender effect and age by gender interaction are as described in the previous paragraph.

Table 8. Breakdown of Appearance in Swimsuit by Gender, Age and Race*

Males:

	White	Black
Less than 26 years:	3.24 (0.57) (n = 206)	3.65 (0.54) (n = 83)
26 or more years:	2.91 (0.63) (n = 366)	3.28 (0.75) (n = 87)

Females:

	White	Black
Less than 26 years:	3.16 (0.77) (n = 86)	3.35 (0.63) (n = 50)
26 or more years:	2.86 (0.74) (n = 33)	3.02 (0.88) (n = 17)

* Values shown are means with std. dev. in parentheses.

Table 9. Analysis of Variance Effects of Race, Gender, and age on swimsuit appearance

Source of Variation	SS	DF	MS	F	Sig of F
Within Cells	229.1	919	.25		
Regression (% Body Fat)	155.69	1	155.69	624.43	.000
Race	.28	1	.28	1.13	.289
Gender	20.80	1	20.80	83.44	.000
Age	.73	1	.73	2.94	.087
Race by gender	.11	1	.11	.46	.497
Race by age	.19	1	.19	.78	.378
Gender by age	1.16	1	1.16	4.65	.031
Race by gender by age	.03	1	.03	.11	.736

Table 10. Breakdown of Fatness Rating by Gender, Age and Race*

Males:

	White	Black
Less than 26 years:	3.33 (0.82) (n = 206)	2.82 (0.81) (n = 83)
26 or more years:	3.93 (0.77) (n = 366)	3.37 (1.10) (n = 87)

Females:

	White	Black
Less than 26 years:	3.58 (0.93) (n = 86)	3.33 (0.84) (n = 50)
26 or more years:	3.89 (0.86) (n = 33)	3.65 (1.02) (n = 17)

---

* Values shown are means with std. dev. in parentheses.

Table 11. Analysis of variance effects of race, gender and age on fatness rating.

Source of Variation	SS	DF	MS	F	Sig of F
Within cells	307.91	919	.34		
Regression (% Body Fat)	354.41	1	354.41	1057.78	.000
Race	.16	1	.16	.48	.487
Gender	47.85	1	47.85	142.82	.000
Age	.46	1	.46	1.37	.243
Race by gender	.41	1	.41	1.23	.267
Race by age	.08	1	.08	.23	.630
Gender by age	.36	1	.36	1.09	.298
Race by gender by age	.01	1	.01	.02	.878

Fatness Rating

Tables 10 and 11 show the breakdown and analysis of variance of the ratings of fatness in swimsuits using the 7-point scale. As was the case for the appearance ratings, the analysis of variance indicated a significant gender effect. The nature of this effect is as it was in the previous analyses: an equal fatness rating will be associated with a greater percent body fat for a woman than for a man.

Figures 4 and 5 have been included to provide a pictorial overview of the results of this study. Figure 4 provides photographs of five male participants, both in swimsuit and in uniform. Accompanying the photographs are the percent fat value (rounded to the nearest 5%) for the individual, the fatness rating, and the swimsuit and uniform appearance ratings. Figure 5 is similar, but includes examples of female participants.

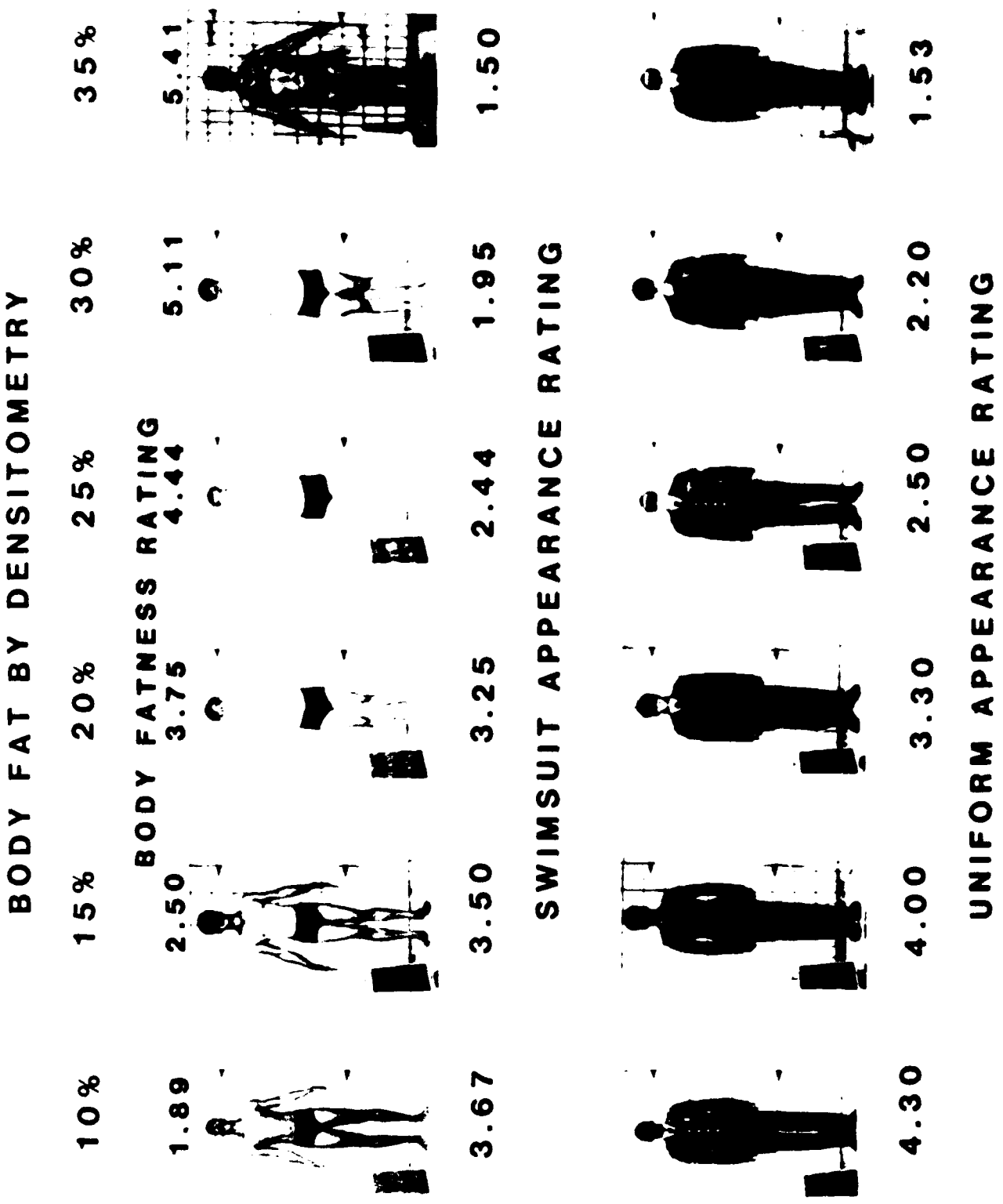


Figure 4. Pictorial overview of male soldiers comparing individual fatness rating, swimsuit and uniform appearance rating at six levels of percent body fat (rounded to the nearest 5%).

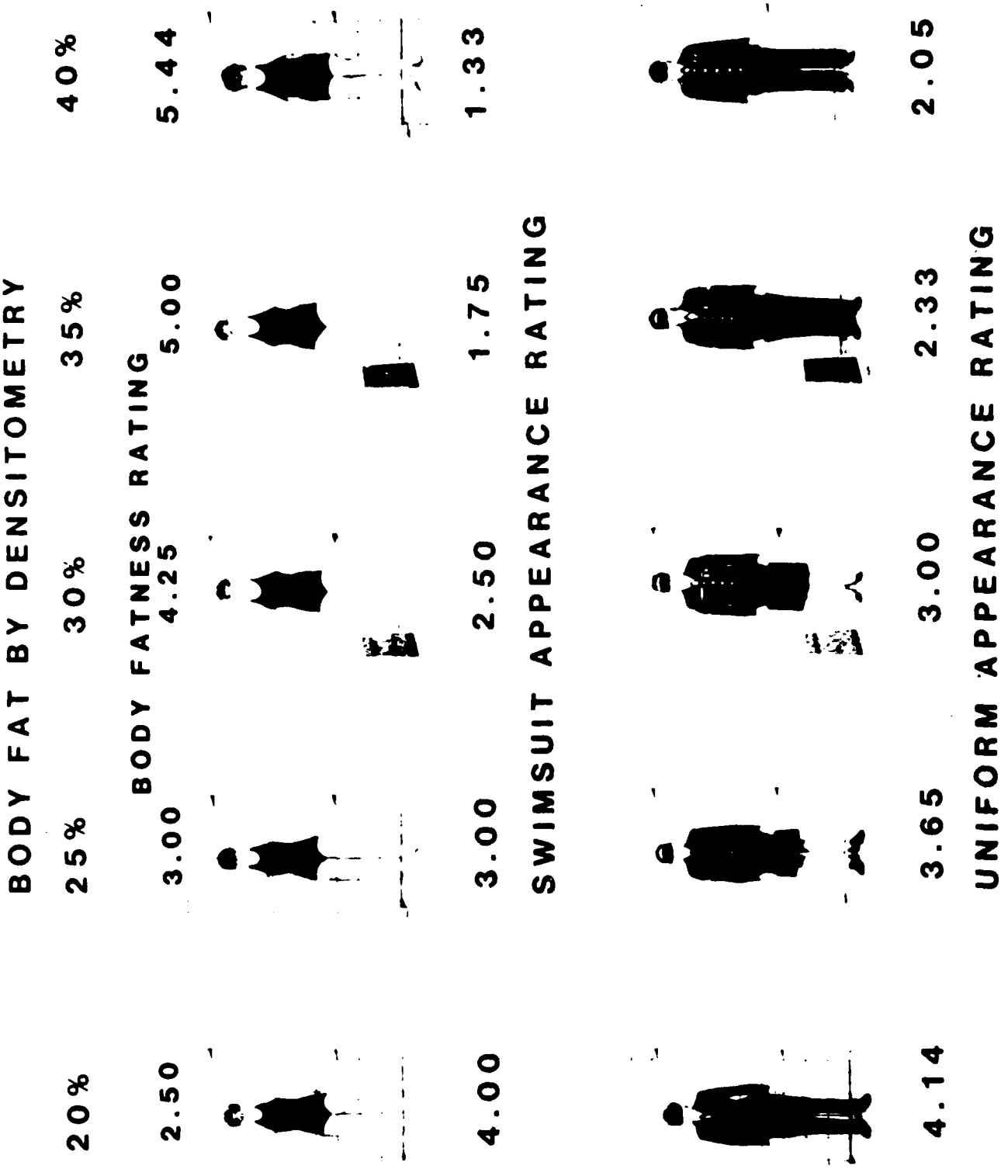


Figure 5. Pictorial overview of female soldiers comparing individual fatness rating, swimsuit and uniform appearance rating at five levels of percent body fat (rounded to the nearest 5%).

DISCUSSION

Reliability of the Measures.

Agreement among raters appears to be rather good for both the appearance and fatness assessments. When the reliabilities are compared between genders, significant differences were not found. The pooled reliability estimates are then 0.86 for ratings of appearance in uniform; 0.90 for ratings of appearance in swimsuit; and 0.92 for fatness assessment. The reliability for fatness estimation appears to be higher than that found by Ward and coworkers (1976). The results presented by Ward, Sutherland, and Blanchard (1976), imply that the inter-rater variation accounts for 39 percent of the total variance. The report does not contain enough information to calculate a value for alpha, but the lower limit for alpha would be 0.625. With only two raters, and limited trials, Sterner (1984) did not determine inter-rater reliabilities.

Relationships among the ratings

As can be seen in Table 3, ratings of appearance in uniform are not strongly related to fatness, either as percent body fat from hydrodensitometry, or as ratings of fatness from photographs. On the other hand, there seems to be a rather strong relationship between ratings of appearance in swimsuit and both measured and rated fatness. Since the ratings in uniform preceded the ratings in swimsuit, these findings may reflect a period of learning of the rating procedure by the raters. These findings may also indicate that factors other than fatness enter into judgements of military appearance when the subject is in uniform. This is not surprising since 1) the uniform often "hides" fatness by forcing the body to conform to the dimensions of the uniform; and 2) the appearance of the uniform itself (medals and other devices lined up properly and properly shined) contributes to the judgement of appearance despite admonitions to the raters not to rate the uniform.

Judgments of military appearance are normally made with soldiers in uniform. Given the weak association between appearance in uniform and percent body fat (only 28% of the variance accounted for), it does not seem reasonable to judge both military appearance and fatness from photographs of soldiers in uniform.

The reasonably strong correlation between ratings of fatness and of appearance in swimsuit suggests much more commonality among factors contributing to the ratings. The fact that these ratings are not even more strongly associated may reflect a difference in the metric (a 7-point scale with which values increase with increasing fatness, vs. a 5-point scale with values decreasing with increasing fatness) between ratings, and/or differences in criteria evaluated for the words "fatness" and "appearance".

Fatness assessments and anthropometric equations.

The validity of the equations to predict percent body fat from fatness assessments approaches the validities associated with prediction of percent fat from anthropometric variables using established generalized equations. Table 12 provides the correlation coefficients and standard errors of measurement for several generalized anthropometric equations applied to this sample. As can be seen from the table the correlations associated with these anthropometric equations are only slightly greater, and the standard errors only slightly less than those associated with the prediction of percent fat from fatness ratings.

Table 12 - Validities of Generalized Anthropometric Equations

Reference	Measures	R	Std. Err. of Measurement
Males:			
Hodgdon & Beckett (1984a)	2 circ., ht	0.83	3.97
Wright, Dotson, & Davis (1980)	2 circ.	0.80	4.18
Behnke & Wilmore (1974)	3 skf.	0.83	4.08
Jackson & Pollock (1976)	7 skf., age	0.86	3.57
Durnin & Womersley (1974)	4 skf., age	0.80	4.19
Vogel, et al (1988)	2 circ., ht	0.83	3.93
	mean=	0.83	
Females:			
Hodgdon & Beckett (1984b)	2 circ., ht	0.74	4.01
Wright, Dotson, & Davis (1981)	2 circ.	0.72	3.89
Behnke & Wilmore (1974)	3 skf.	0.77	3.83
Jackson, Pollack, & Ward (1976)	7 skf., age	0.75	4.00
Durnin & Womersley (1974)	4 skf., age	0.74	3.97
Vogel, et al (1988)	4 circ., wt, ht	0.78	3.52
	mean=	0.75	

A recent article by Mueller and Malina (1987) indicates the inter-rater reliability for skinfold measurements is approximately 0.92, and that for circumference measurements is 0.96. The inter-rater reliability of the visual fatness assessments is comparable to that of skinfold measurement but slightly less than that of circumference measurement. While the reliability of the fatness assessment can be improved by increasing the number of raters, it would not be practical here. Using the formulae provided in Nunnally (1978), an inter-rater reliability of 0.96 can be achieved by doubling the rating group size.

While the validity of fatness assessment approaches that of estimation from anthropometric variables, the technique would be impractical for military use. If assessment of fatness were dependent upon the ratings of 5 raters, as an example of the size of a typical rating board, the reliability would drop to 0.865 and the estimated correlation between the average fatness assessment and percent body fat

from hydrodensitometry in this sample would be 0.74 for men and 0.68 for women. This degradation in validity would render the visual rating process unworkable.

Gender differences in ratings.

The ANOVA results indicate significant gender effects in the ratings of appearance and of fatness. For a given rating, a woman will have a greater percent body fat by about 8.7 % relative fat than a man. This finding is of interest given the literature that suggests that for comparable age, the percent fat for healthy women will exceed that for men by approximately 10 % relative fat (Behnke and Wilmore, 1974; Carter, 1983; McArdle, Katch, and Katch, 1986). It would appear that this naturally occurring difference is taken into account in visual ratings using the same scale for men and women. That the difference in fatness for the same rating is 8.7% fat rather than 10, may reflect that individuals comprising the male sample were, on the average, older than those comprising the female sample.

CONCLUSIONS

From the above, we conclude:

1) Ratings of appearance involve more than a consideration of the fatness of the individual. Ratings of appearance in uniform are not sufficiently strongly related to percent body fat to justify their use in body fat prediction. Therefore, it is not feasible to establish a single rating procedure which can be used to rate both military appearance and fatness.

2) Visual ratings of fatness, appear to be valid, reliable indicators of percent body fat. Their use appears to be constrained by the size of the group (approximately 9) needed to achieve the validities approaching those associated with anthropometric equations.

REFERENCES

Behnke, A.R. and J.H. Wilmore. (1974) Evaluation and Regulation of Body Build and Composition. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Blanchard, J.M., G.M. Ward, H.J. Krzywicki and J.E. Canham. (1979) A visual appraisal method for estimating body composition in humans. Institute Report No. 81. Letterman Army Institute of Research, Presidio of San Francisco, CA.

Brozek, J. and A. Keys. (1952) Body Build and Body Composition. Science 116:140-142.

Buskirk, E.R. (1961) Underwater weighing and body density. A review of procedures. pp 90-107 In: J. Brozek and A. Henschel (eds). Techniques for Measuring Body Composition. National Academy of Sciences, National Research

Council, Washington, DC.

Carmines, E.G. & R.A. Zeller. (1979) Reliablility and Validity Assessment. Sage Publications, Beverly Hills, CA.

Carter, J.E.L. (1983) Kinanathropometry Notes. San Diego State University, San Diego, CA.

Diem, K. (ed). (1962) Scientific Tables, 6th edition. Geigy Pharmaceuticals Ardsley, NY.

Dupertuis, C.S. (1950) Anthropometry of extreme somatotypes. Amer. J. Phys. Anthrop. 8:367-385.

Durnin, J.V.G.A., and J. Womersely. (1974) Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged 16 to 72 years. Brit. J. Nutr. 32:77-97.

Fitzgerald, P.I., J.A. Vogel, W.L. Daniels, J.E. Dziados, M.A. Teves, R.P. Mello, and P.J. Reich. (1986) The body composition project: a summary report and descriptive data. Technical Roport No. T5-87. U.S. Army Research Institute of Environmental Medicine, Natick, MA.

Fitzgerald, P.I., J.A. Vogel, J. Miletti, and J.M. Foster. (1987) An improved portable hydrostatic weighing system for body composition. Technical Report No. T4-88. U.S. Army Research Institute of Environmental Medicine, Natick, MA.

Goldman, R.F. and E.R. Buskirk (1961) Body volume measurement by underwater weighing: Description of a method. pp 78-89 In: J. Brozek and A. Henschel (eds). Techniques for Measuring Body Composition. National Academy of Sciences, National Research Council, Washington, DC.

Jackson, A.S. and M.L. Pollack. (1978) Generalized equations for predicting body density of men. Brit. J. Nutr. 40:497-504.

Jackson, A.S., M.L. Pollack, and A. Ward. (1980) Generalized equations for predicting body density of women. Med. Sci. Sports and Exercise. 12:175-182.

McArdle, W.D., F.I. Katch, and V. L. Katch. (1986) Exercise Physiology, Energy, Nutrition, and Human Performance. Lea & Febiger, Philadelphia, PA.

Mueller, W.H. and R.M. Malina. (1987) Relative reliability of circumferences and skinfolds as measures of body fat distribution. Am. J. Physical Anthropol. 72:437-439.

National Institutes of Health. (1985) Health implications of obesity. National Institutes of Health Consensus Development Conference Statement, vol. 5 no. 9. U.S. Department of Health and Human Services, Washington, DC.

Nunnally,J.C. (1978) Psychometric Theory. McGraw-Hill, New York, NY.

Sheldon, W.H. (1940) The Varieties of Human Physique. Harper. New York, NY.

Siri, W.E. (1961) Body composition from fluid spaces and density: Analysis of methods. pp 223-244 In: J. Brozek and A. Henschel (eds). Techniques for Measuring Body Composition. National Academy of Sciences, National Research Council, Washington, DC.

SPSS, Inc. (1988) SPSS-X Users Guide, 3rd Edition. SPSS, Inc., Chicago, IL.

Sterner, T.G. (1984) Relationship between percent body fat as determined by visual estimation and underwater hydrostatic weighing. Masters Thesis, Springfield College, Springfield, OH.

Tanner, J.M. and J.S. Werner. (1949) The reliability of the photogrammetric method of anthropometry with a description of a miniature camera technique. Amer. J. Phys. Anthrop. 7:145-186.

Vogel, J.A., J.W. Kirkpatrick, P.I. Fitzgerald, J.A. Hodgdon, and E. Harman. (1988) Derivation of anthropometry based body fat equations for the Army's weight control program. Technical Report No. T17-88. U.S. Army Research Institute of Environmental Medicine, Natick, MA.

Ward, G.M., T.M. Sutherland, & J.M. Blanchard. (1976) Evaluation of body composition of human subjects by means of visual appraisal. Final Report, Contract # DAMD 17-74-C-4072, Colorado State University, Fort Collins, CO.

Wilmore, J.H., P.A. Vodak, R.B. Parr, and R.N. Girandola. (1980) Further simplification of a method for determination of residual lung volume. Med. Sci. Sports Exerc. 12:216-218.

Wright, H.W., C.O. Dotson, and P.O. Davis. (1980) An investigation of assessment techniques for body composition of women Marines. U.S. Navy Med., 71(5):15-26.

Wright, H.W., C.O. Dotson, and P.O. Davis. (1981) A simple technique for measurement of percent body fat in man. U.S. Navy Med., 72(5):23-27.

Appendix A.
FATNESS RATING SCALE

Score	Description:	
1	(no visible fat)	The person has no fat visible as viewed from these photos.
2	(very thin)	Muscle attachments and blood vessels are clearly seen below the skin surface; a slight amount of fat tissue can be deposited in the extreme lower back, inner thigh area and immediately below the buttock. Abdominal muscling is clearly visible, facial lines are angular and the neck appear to be free of fat deposits.
3	(thin)	Locations of muscle attachments are moderately visible. Blood vessels can be seen below the skin, although they are not clearly visible. Abdominal muscles can be seen to some degree although a slight layer of fat is now deposited in the abdominal area. Facial lines are still fairly angular and free of fat.
4	(moderate)	Location of muscle attachments are not clearly visible. Body lines in general are somewhat smooth in appearance. Abdominal muscle are not clearly visible due to fat tissue covering; however, the stomach does not protrude over the waistline. Facial characteristics are probably best described as being smooth and more circular in appearance than the leaner subjects.
5	(fat)	Body lines are smooth but are now becoming rounded. Abdominal muscles are not visible due to fat deposits. Stomach protrudes over the waistline about 0-3.5 cm. Fat deposits on torso sides protrude over the waistline slightly. Facial lines are rounded.
6	(very fat)	No muscling is clearly visible due to fat deposits. Stomach protrudes over the waistline at least 3.5-4.0 cm and there are fat deposits protruding over the waistline on the sides. Facial lines are very rounded and the area under the jaw and around the neck have substantial amounts of fat deposited.
7	(obese)	

DISTRIBUTION LIST

2 Copies to:

Commander
U.S. Army Medical Research and
Development Command
ATTN: SGRD-OP
Fort Detrick
Frederick, MD 21701-5012

2 Copies to:

Commander
U.S. Army Medical Research and
Development Command
ATTN: SGRD-PLC
Fort Detrick
Frederick, MD 21701-5012

1 Copy to:

Commandant
U.S. Army Academy of Health Sciences
ATTN: AHS-COM
Fort Sam Houston, TX 78234-6100

1 Copy to:

Stimson Library
U.S. Army Academy of Health Sciences
ATTN: Chief Librarian
Bldg. 2840, Room 106
Fort Sam Houston, TX 78234-6100

1 Copy to:

Director, Biological Sciences Division
Office of Naval Research - Code 141
800 N. Quincy Street
Arlington, VA 22217

1 Copy to:

Commanding Officer
Naval Medical Research and Development Command
NMC-NMR/Bldg. 1
Bethesda, MD 20814-5044

1 Copy to:

Office of Undersecretary of Defense for Acquisition
ATTN: Director, Defense Research and Engineering
Deputy Undersecretary for Research & Advanced Technology
(Environmental and Life Sciences)
Pentagon, Rm 3D129
Washington, D.C. 20301-3100

1 Copy to:

Dean
School of Medicine
Uniformed Services University Of The Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814-4799

2 Copies to:

Commander
U.S. Air Force School of Aerospace Medicine
Brooks Air Force Base, TX 78235-5000

2 Copies to:

Commander
Naval Health Research Center
P.O. Box 85122
San Diego, CA 92138-9174

2 Copies to:

Commander
U.S. Army Biomedical Research and Development Laboratory
Fort Detrick
Frederick, MD 21701-5010

2 Copies to:

U.S. Army Military Liaison Officer to DCIEM
1133 Sheppard Avenue W.
P. O. Box 2000
Downsview, Ontario
Canada M3M 389

1 Copy to:

Commandant
Walter Reed Army Institute of Research
Walter Reed Army Medical Center
Acting Director for Research Management
ATTN: SGRD-UWZ-C
Washington, D.C. 20307-5100

1 Copy to:

HQDA
Training Directorate, ODCSOPS
ATTN: DAMO-TRO/LTC Crumling
Washington, DC 20310

1 Copy to:

Director
Army Physical Fitness Research Institute
Box 469
U. S. Army War College
Carlisle Barracks, PA 17013

1 Copy to:

Director
Army Physical Fitness Center
ATTN: ATSG-PF/LTC O'Connor
U. S. Army Soldier Support Institute
Fort Benjamin Harrison, IN 46216

1 Copy to:

Dr. M.F. Haisman
Head, Applied Physiology
Army Personnel Research Establishment
c/o RAE, Farnborough
Hants, GU14 6TD
United Kingdom

1 Copy to:

Flight Lieutenant S.J. Legg
Defense Environmental Medicine Unit
RNZAF Base Auckland
Post Office
Whenuapai

Auckland, New Zealand

1 Copy to:

HQDA
SGPS-FP
5109 Leesburg Pike
Falls Church, VA 22041-3258

1 Copy to:

HQDA
DASG-PSP
5111 Leesburg Pike
Falls Church, VA 22041-3258

1 Copy to:

Headquarters
U. S. Army Training and Doctrine Command
Command Surgeon's Office
Fort Monroe, VA

1 Copy to:

U. S. Army Human Engineering Laboratory
ATTN: DRXHE-IS
Aberdeen Proving Ground, MD 21005